



U.S. DEPARTMENT OF
ENERGY

OFFICE OF
**ENVIRONMENTAL
MANAGEMENT**



Proposal to Update New Mexico Water Quality Standards: Copper Site-Specific Water Quality Criteria for the Pajarito Plateau

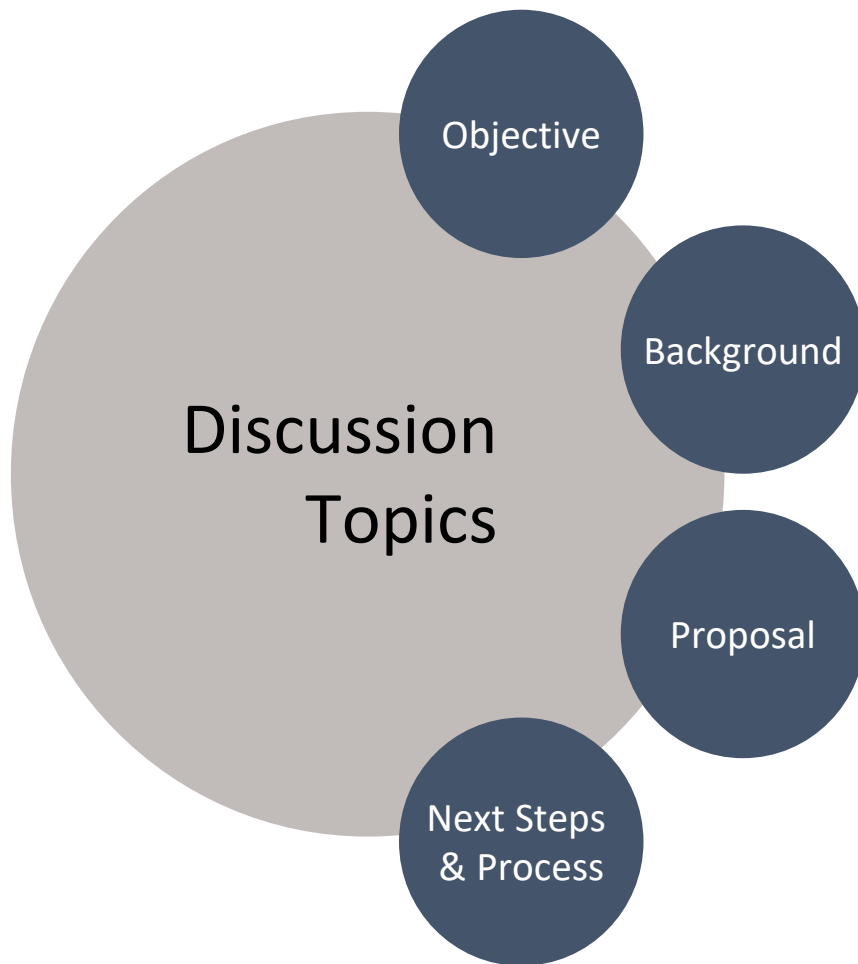
*Presented by
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Windward Environmental, LLC*



ENVIRONMENTAL MANAGEMENT
SAFETY ♦ PERFORMANCE ♦ CLEANUP ♦ CLOSURE

June 16, 2021







Develop a proposal for the New Mexico Water Quality Control Commission to adopt EPA's 2007 recommended copper ambient water quality criteria.





What is copper?

- An element that naturally occurs in Earth's crust and surface water

How does copper enter surface waters?

- Through both natural and anthropogenic sources
 - Natural sources: rock weathering, volcanic activity and geological deposits
 - Anthropogenic sources: mining activities, agriculture, pesticide use, urban runoff and more





How does copper affect aquatic life?

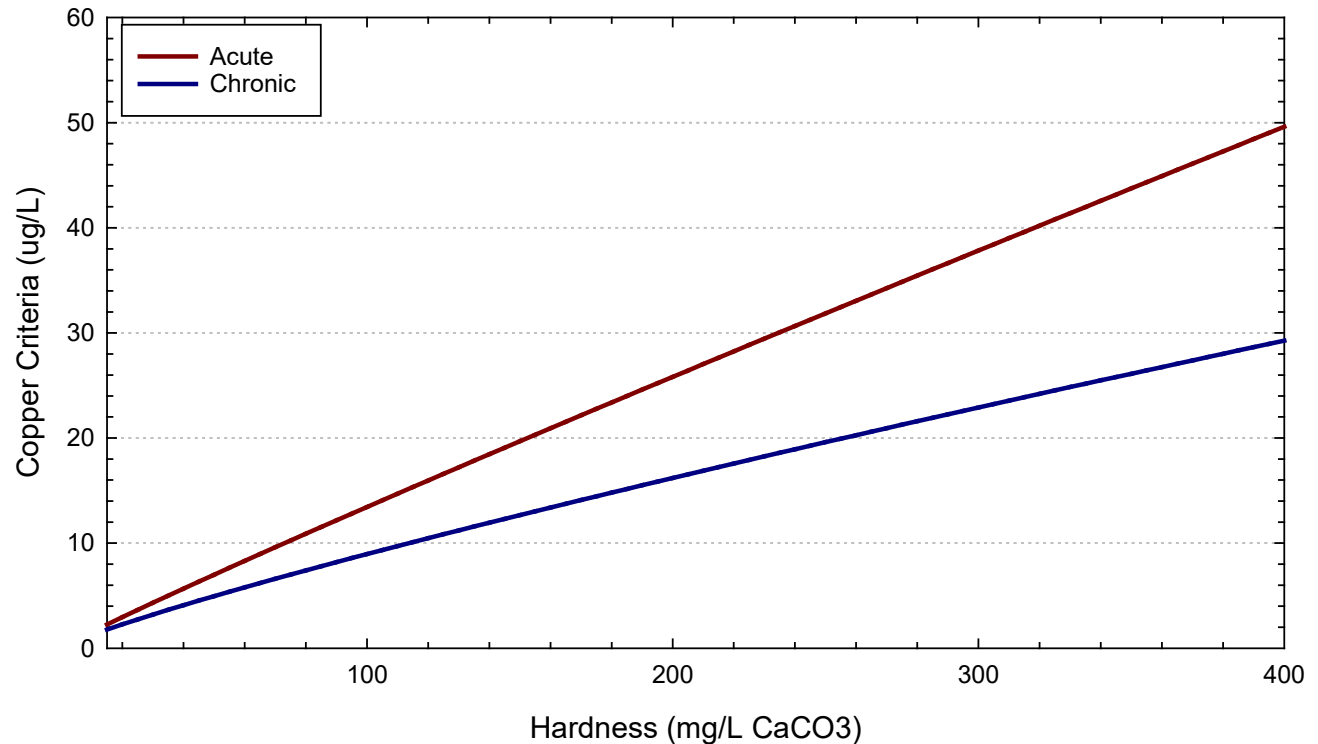
- Copper is an essential nutrient at low concentrations but can be toxic at elevated concentrations
- The **bioavailability** and toxicity of copper to aquatic life depends on site-specific water chemistry (EPA 2007)

Bioavailability is the proportion of a substance that enters the animal and plant life of a particular region and is able to have an active effect of those organisms.





- EPA previously addressed water chemistry and copper bioavailability by adjusting criteria to water hardness (EPA 1996, 2016)

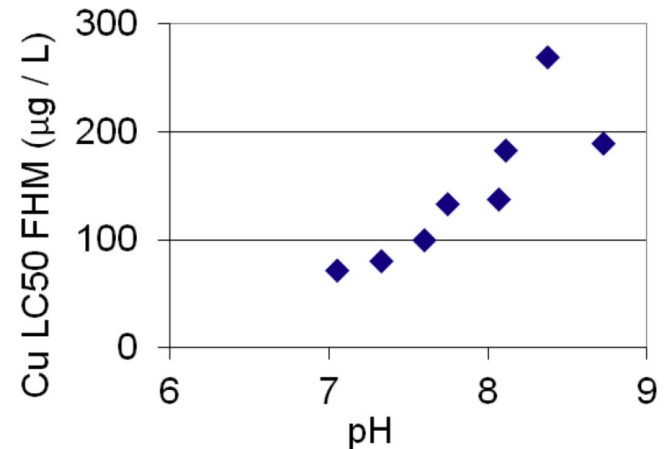
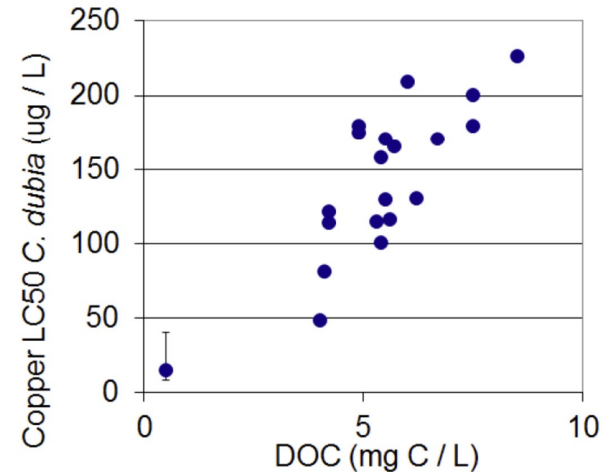




- Hardness-based criteria do not consider other water chemistry parameters (e.g., pH and dissolved organic carbon)

Dissolved organic carbon (DOC) is organic material dissolved in water. DOC in water binds to copper, however, reducing its bioavailability to aquatic organisms.

- Therefore, hardness-based criteria do not reflect all the effects of water chemistry on metals bioavailability (USEPA 2007, 2016)
- U.S. EPA developed the copper biotic ligand model (BLM) to reflect the latest scientific knowledge on metals speciation and bioavailability (EPA 2007, 2016)





History of U.S. EPA National Recommended Aquatic Life Criteria for Copper

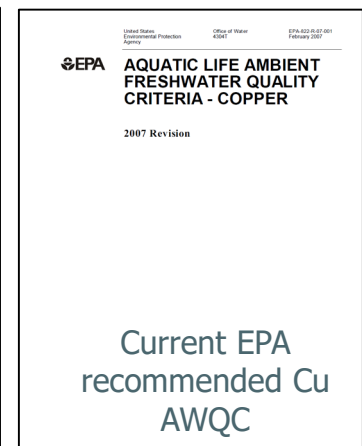
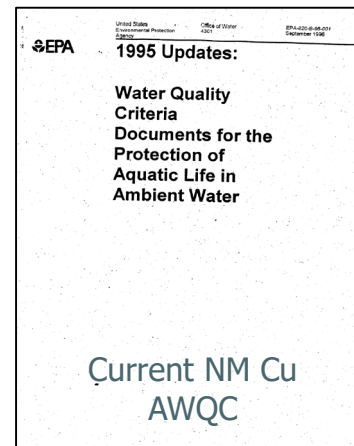
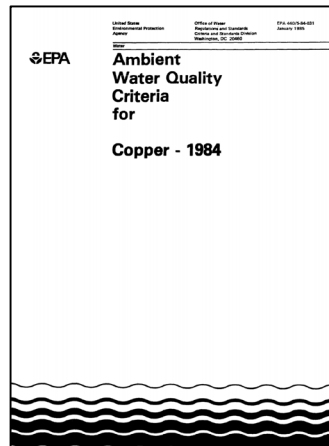
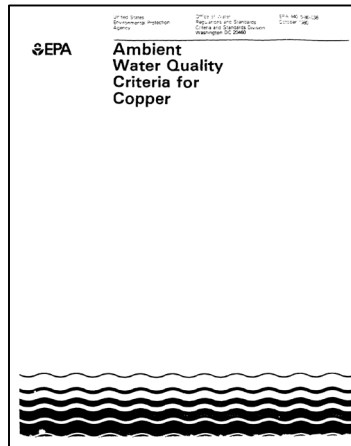
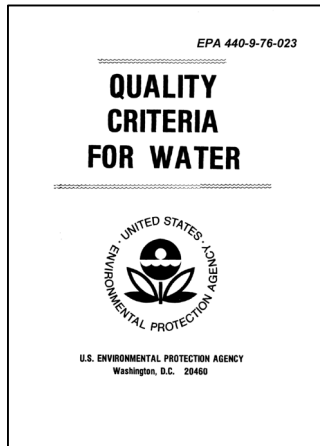
1976 "Red Book"

1980

1984

1995

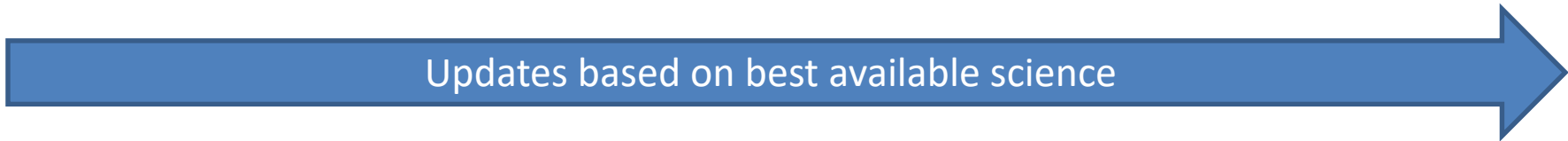
2007 "Cu BLM"



Hardness-Based Criteria



Basis of SSWQC proposal





NMAC §20.6.4.10 D(1):

Site-specific water quality criteria may be developed based on relevant site-specific conditions, such as:

- a Actual species present at a site
- b Physical or chemical characteristics alter the bioavailability and/or toxicity of a chemical
- c Physical, biological, or chemical factors alter the bioaccumulation potential of a chemical
- d Natural background exceed numeric criteria
- e Other factors or combination of factors approved by the commission



Water chemistry influences copper bioavailability and toxicity (EPA 2007).





NMAC §20.6.4.10 D(4):

A derivation of site-specific criteria shall rely on a scientifically-defensible method such as:

- a The recalculation procedure, the water-effect ratio procedure, or the resident species procedure
- b The streamlined water-effect ratio procedure for copper
- c The biotic ligand model (BLM) for copper**
- d EPA methods for deriving AWQC for human health
- e A determination of natural background

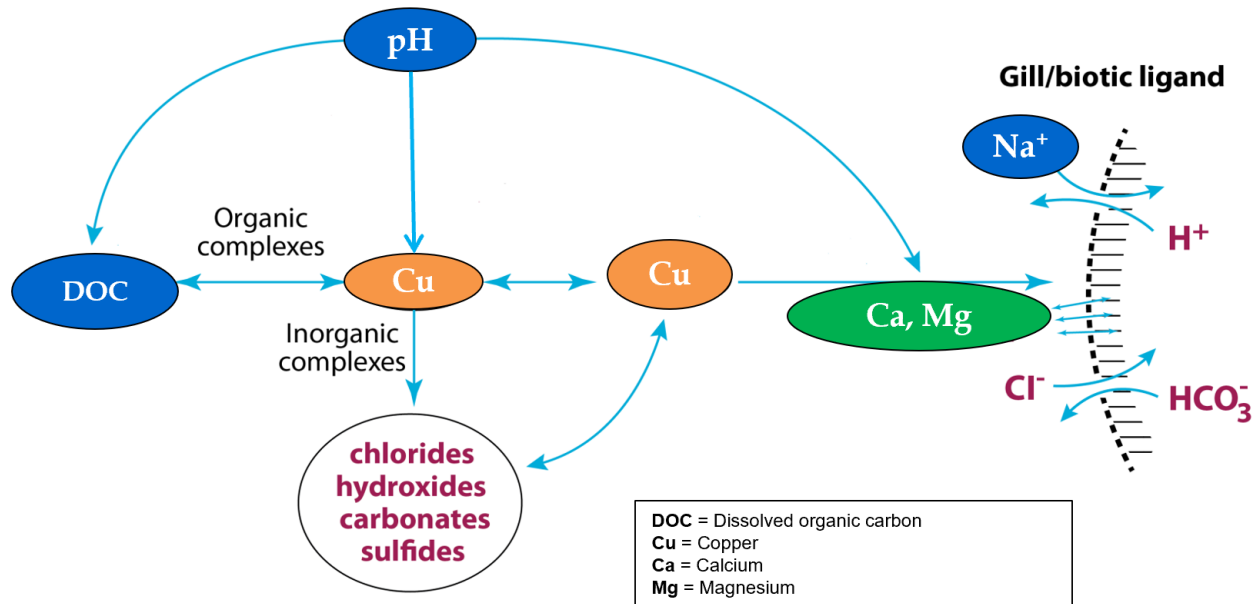


**Current EPA-
recommended copper
water quality criteria (EPA
2007).**





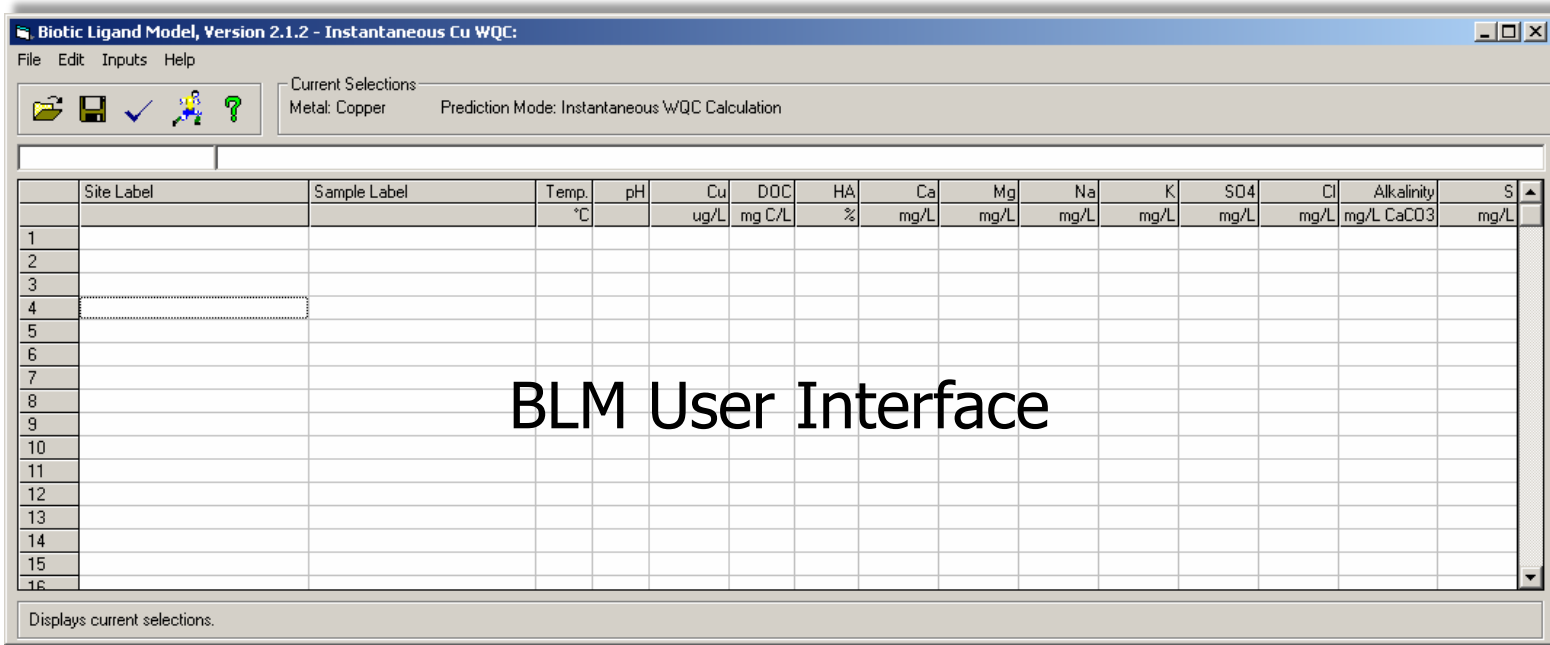
- A software tool used in aquatic toxicology that examines the bioavailability of metals in the aquatic environment and the affinity of these metals to accumulate in aquatic organisms
- Best available science
- Basis for national recommended criteria



Green indicates only parameters used in hardness-based AWQC

Blue indicates additional parameters used in BLM-based AWQC





BLM User Interface

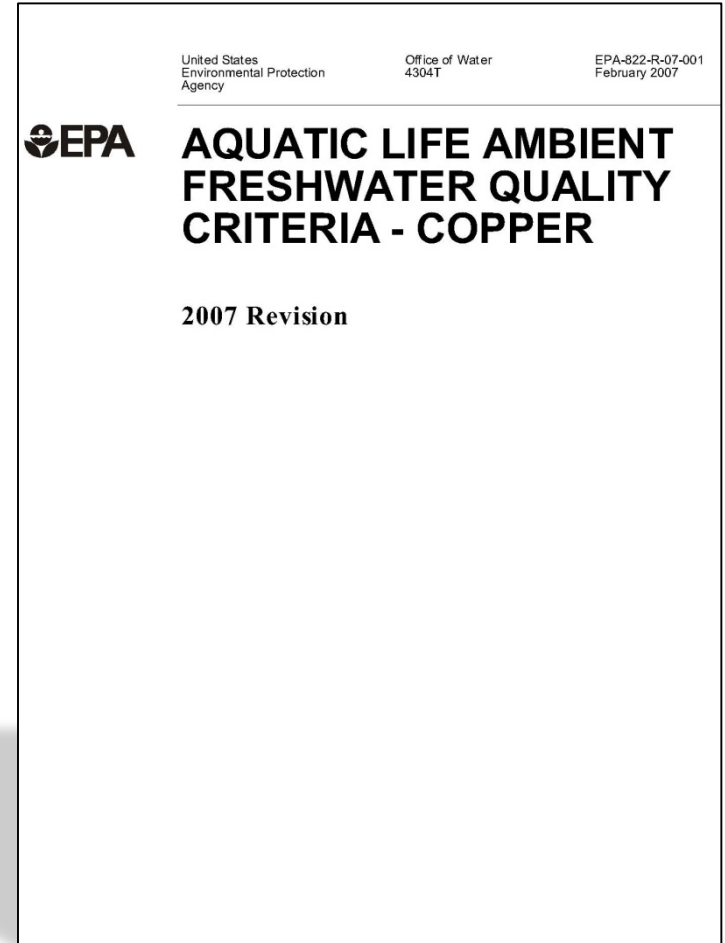
- Not all BLM parameters are significant
- Therefore, the BLM software can be simplified into an equation consistent with other aquatic life criteria (e.g., aluminum, ammonia & others)
- A BLM-based equation has several advantages over BLM software:
 - Readily incorporated into water quality standards
 - No software version control issues
 - No special training required to run software
 - Streamlines monitoring & assessments





Protectiveness of BLM-based Copper Criteria

- Hardness-based criteria are potentially under-protective (i.e., not stringent enough) or over-protective (i.e., too stringent) depending on site-specific water chemistry (EPA 2020).
- “Stringency” varies depending on water chemistry of the site (EPA 2020).



EPA 2020: <https://www.epa.gov/wqc/supplementary-training-materials-background>





Protectiveness of BLM-based Copper Criteria

- BLM-based criteria will provide the level of protection that is intended to protect aquatic life based on EPA guidelines (EPA 2007).
- BLM-based criteria should be neither under-protective nor over-protective (EPA 2020).

	Level of Protection Provided	Reliability
Hardness-based criteria		
BLM-based MLR criteria		



As established in EPA's 1985 Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses (PB85-227049)



More reliable



Less reliable (do not capture the effects of pH and DOC on copper bioavailability and toxicity)



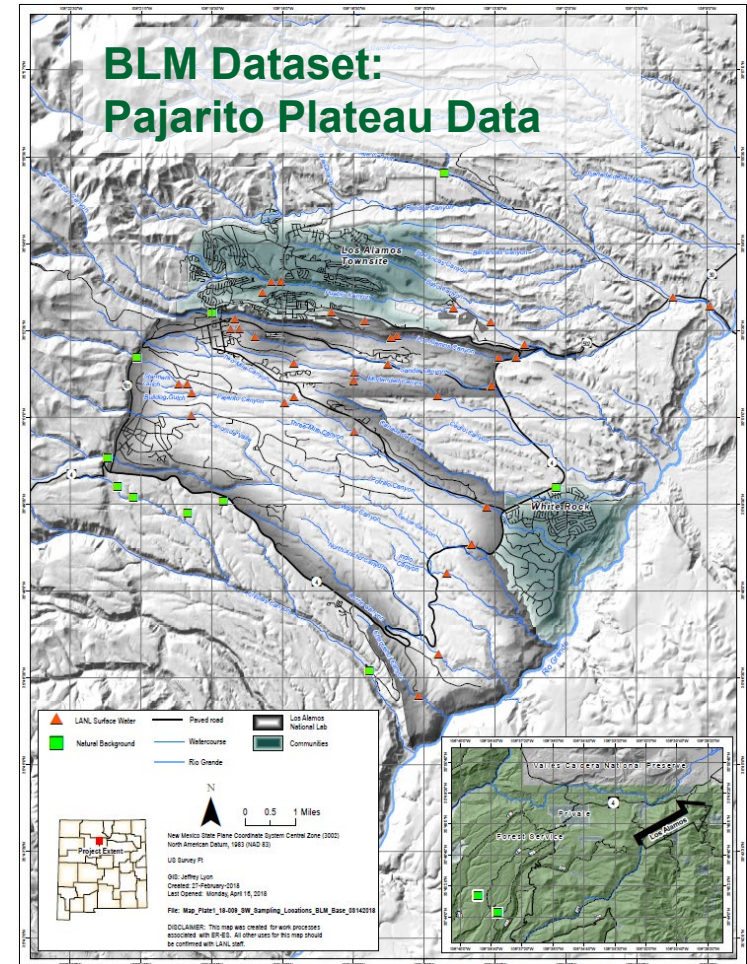
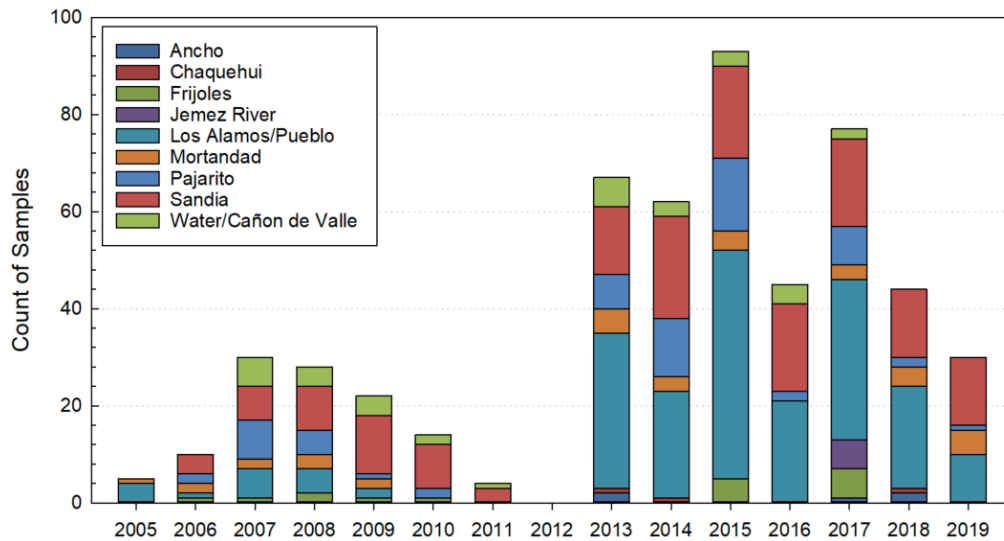


- To reflect best available science, EPA recommendations & NMED-approved methods
- Long-term dataset conducive to setting BLM-based criteria
- Encouraged by NMED and EPA during last individual stormwater permit (IP) renewal
- Recognized by NMED in their last 303(d) assessment for copper
- Responsible use of public dollars





- 531 samples have been collected for this study
- Collected under Quality Assurance/Quality Control and validation programs
- Spans numerous watersheds
- Captures a wide range of water chemistry and hydrology conditions





Overview of Proposed Cu Site-Specific Water Quality Criteria (SSWQC)

- **Current NM Cu Water Quality Criteria (WQC):**
 - Based on EPA (1996) hardness equation
- **Current EPA (§304a) Cu WQC:**
 - Based on EPA (2007) biotic ligand model (BLM)
- **Approach for Cu SSWQC for the Pajarito Plateau:**
 - Build an equation (like the hardness equation) with other water chemistry parameters as needed to accurately generate BLM-based criteria
 - Called a Multiple Linear Regression (MLR) equation





Current NM Cu WQC

Cu WQC Equation

EPA Reference

$$\text{Cu WQC} = \text{Exp} [\text{Intercept} + f(\text{hardness})]$$

EPA (1996)

Proposed SSWQC for Pajarito Plateau

$$\text{Cu WQC} = \text{Exp} [\text{Intercept} + f(\text{pH}) + f(\text{DOC}) + f(\text{hardness})]$$

EPA (2007)





$$SSWQC_{acute} = \exp(-22.912 + 1.017 \cdot \ln(DOC) + 0.045 \cdot \ln(hardness) + 5.176 \cdot pH - 0.261 \cdot pH^2)$$

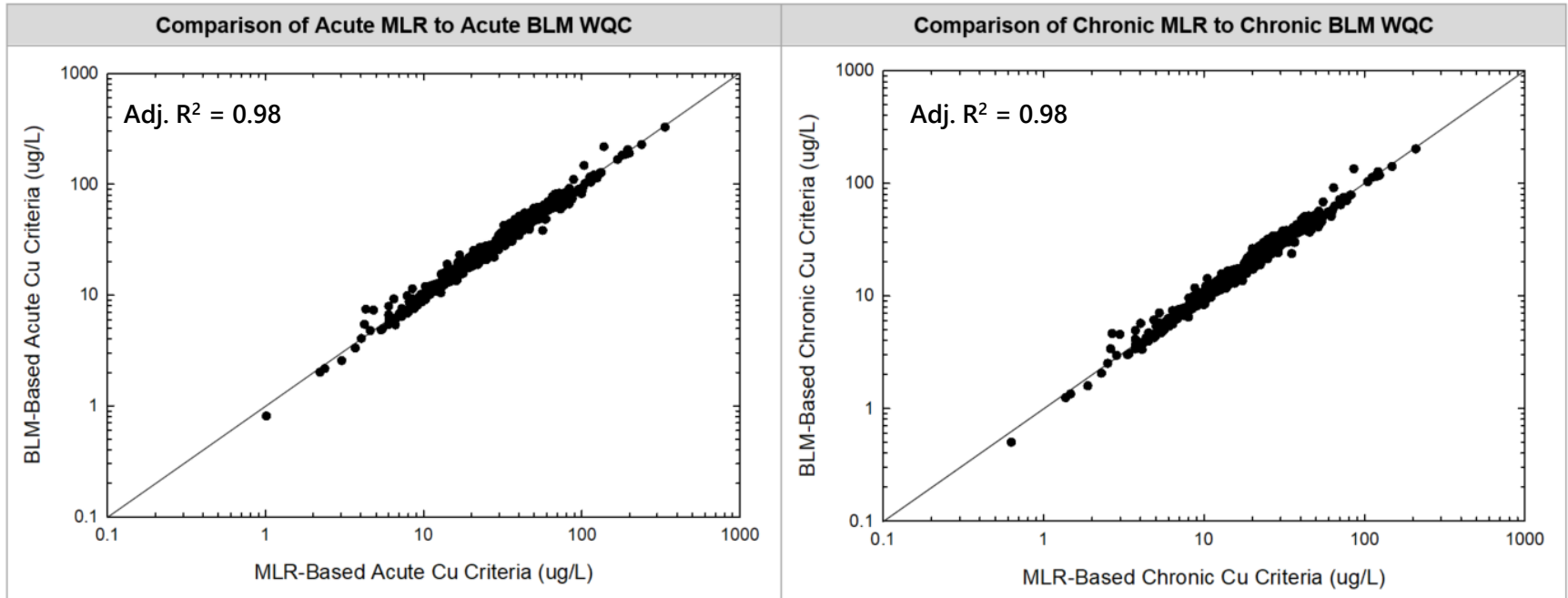
$$SSWQC_{chronic} = \exp(-23.382 + 1.017 \cdot \ln(DOC) + 0.045 \cdot \ln(hardness) + 5.174 \cdot pH - 0.261 \cdot pH^2)$$

- Works well across ephemeral, intermittent, perennial streams
 - Applicable to any waterbody on the Pajarito Plateau





MLR Comparison to BLM



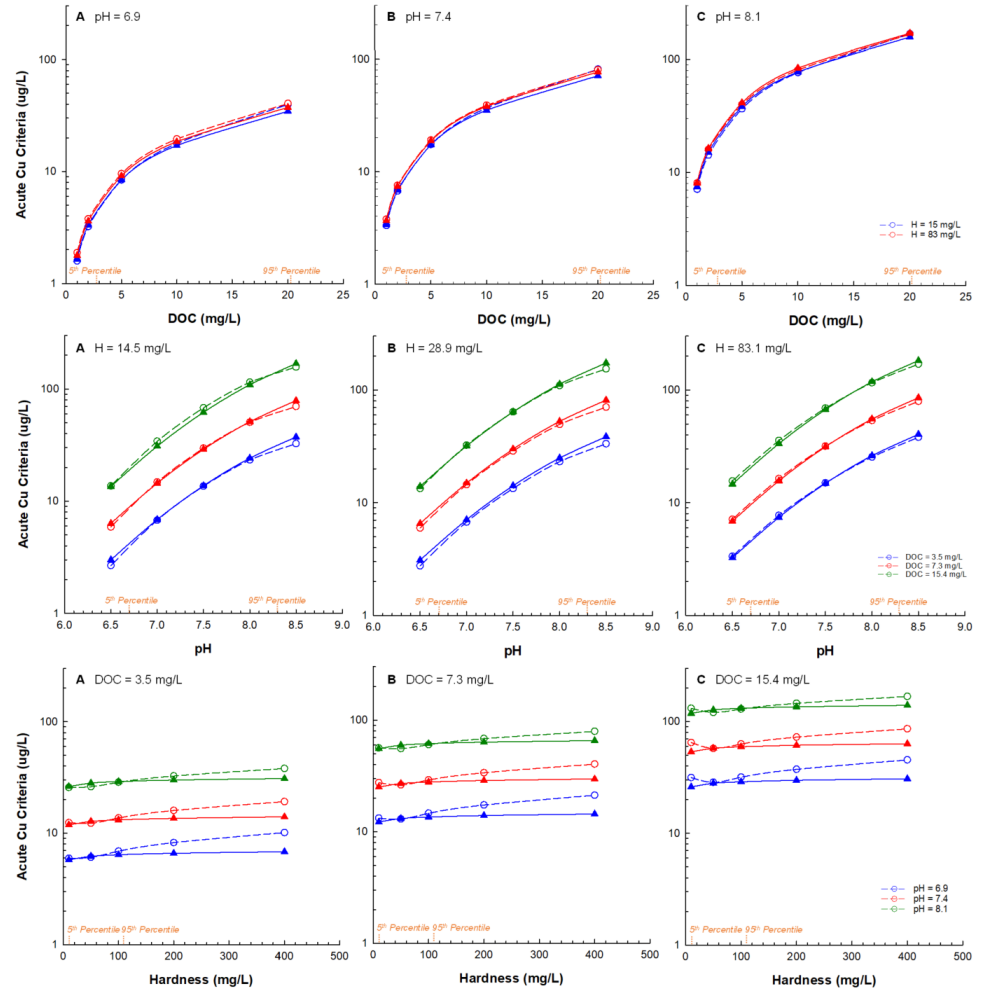
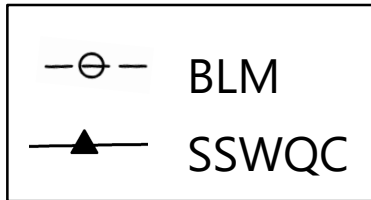
Note: solid line represents a 1:1 relationship (perfect agreement).

N = 517 samples (BLM dataset for the Pajarito Plateau excluding samples outside the BLM prescribed ranges for pH, DOC, and hardness)





Validation Across Ranges of Observed Conditions





1. Demonstration Report

- Presents and justifies derivation of copper SSWQC pursuant to 20.6.4.10 NMAC requirements

2. Agency Review

- NMED & EPA review and comments on Demonstration Report

3. Stakeholder & Public Review

- Targeting Q3 2021 for public review draft of Demonstration Report
- Written comments will be solicited
- Additional public meetings will be scheduled

4. Petition & Rulemaking

- A petition for copper SSWQC will be developed based on (1) conclusions presented in the final Demonstration Report, (2) NMED and EPA comments, and (3) comments from other potential stakeholders, tribes, and the general public





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Questions



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Produced by Los Alamos Legacy Cleanup Contractor, N3B Los Alamos
on behalf of DOE's Environmental Management Los Alamos Field Office





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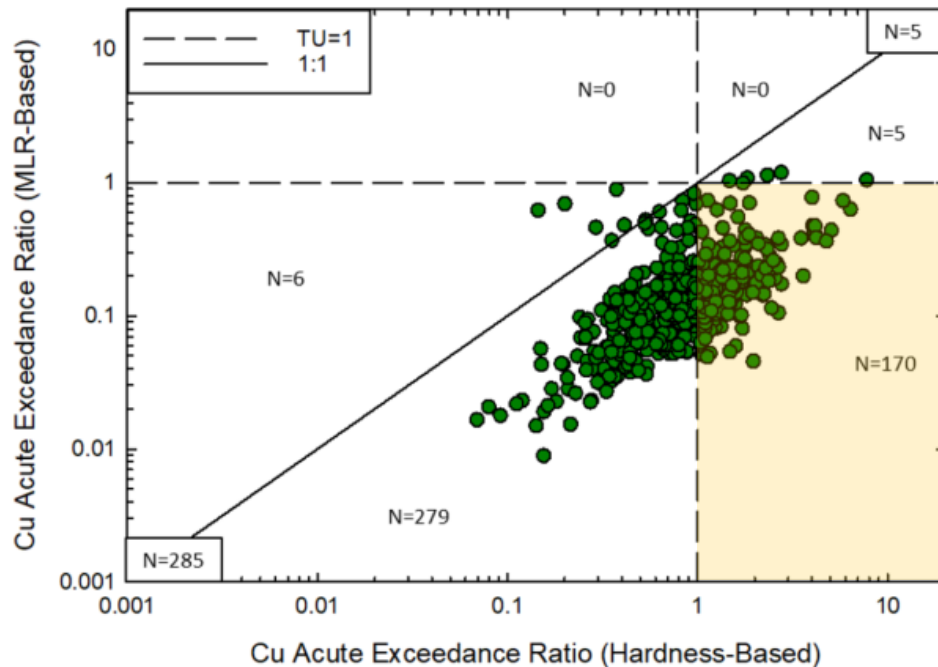
Backup Slides (as needed)



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- 175 exceedances of current hardness-based WQC
- 5 exceedances of proposed hardness, pH & DOC-based SSWQC
- Every point in the shaded lower right-hand quadrant represents a false positive WQC exceedance
 - 170 false positives
 - 5 true positives
 - 285 true negatives

Note: excludes samples with Cu detection limits > BLM or hardness-based criteria

Exceedance Ratio = Cu concentration / WQC

